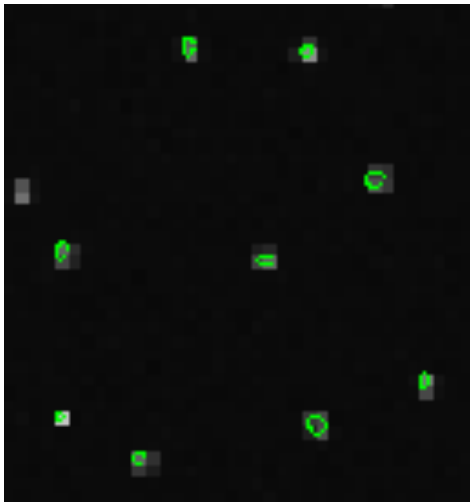
Using Fe^{55} X-Rays to Characterize CCDs

Andrew Walsworth
Duke University

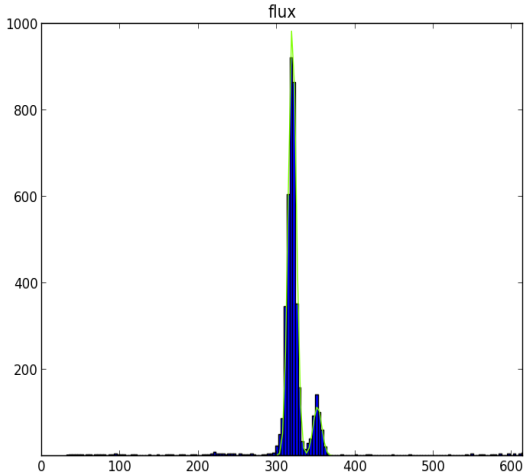
Goals at BNL

- Investigate lateral field effects in CCD (i.e. tree rings) by looking at ellipticity of Fe^{55} hits
- Check edge effects with real data (Max will have more on edge effects with simulated data)
- Resolve Fe^{55} undersampling issue

Early Results - Flux

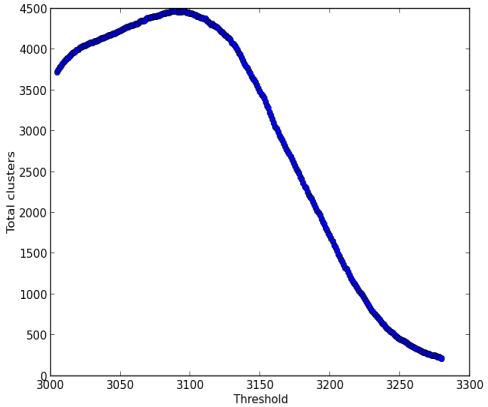


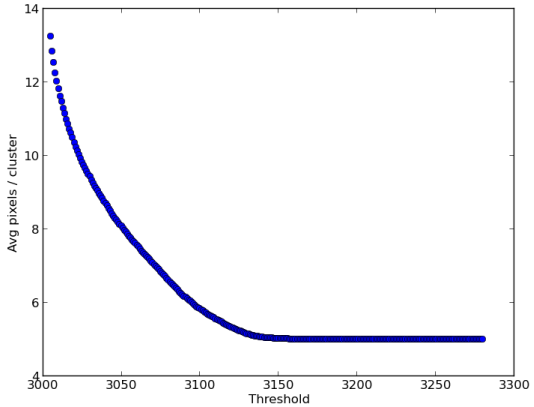
- Fe^{55} has characteristic 2 peak signal - k_a and k_b
- k_a approx 7x more frequent than k_b
- Observed distribution quite Gaussian
- Only interested in single-hit clusters

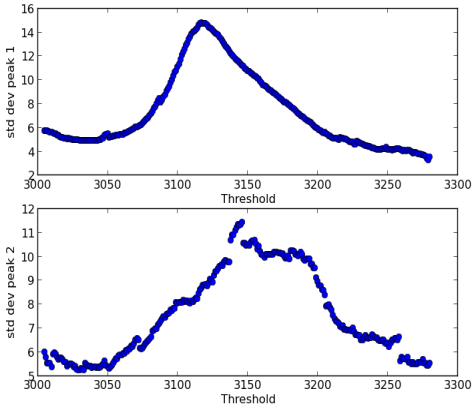


Threshold Value

- What is the ideal threshold value for analyzing footprints?
- Analysis done before background-subtracting implemented
- Sweet spot at ~3020 ADU (~20 w/ background subtracted)



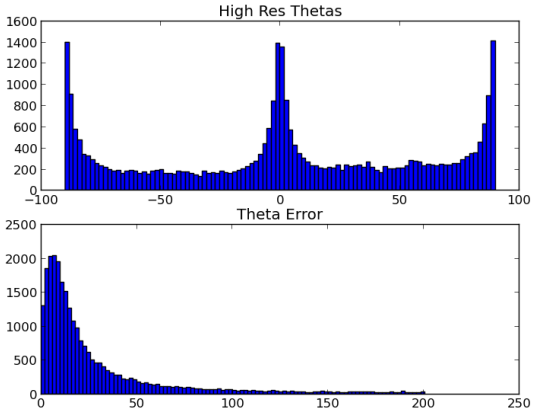




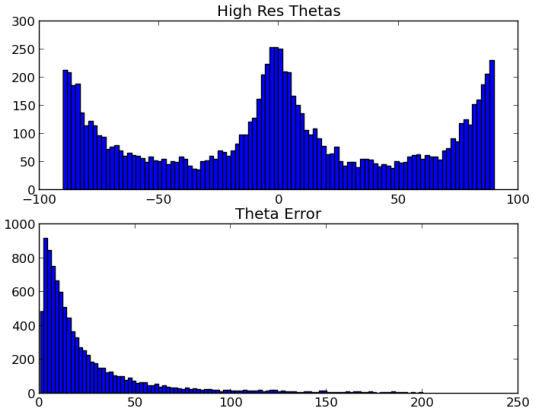
Recent Activities - Undersampling

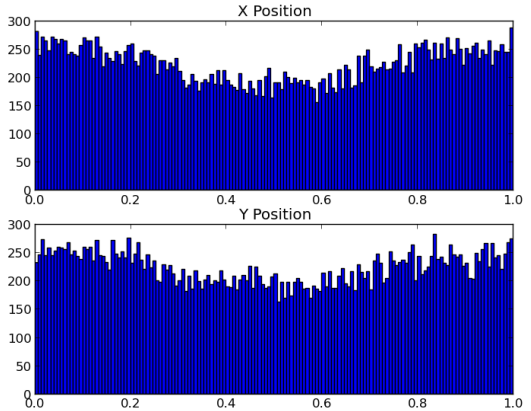
- Fe^{55} clusters are quite small and prone to undersampling
- Undersampling - leads to spiky theta distributions and a bias away from signals that hit at the center of the pixel
- In addition to subpixel sampling, Xi^2 limits could further mitigate these issues

Before Xi^2 selection:



After Xi^2 selection:





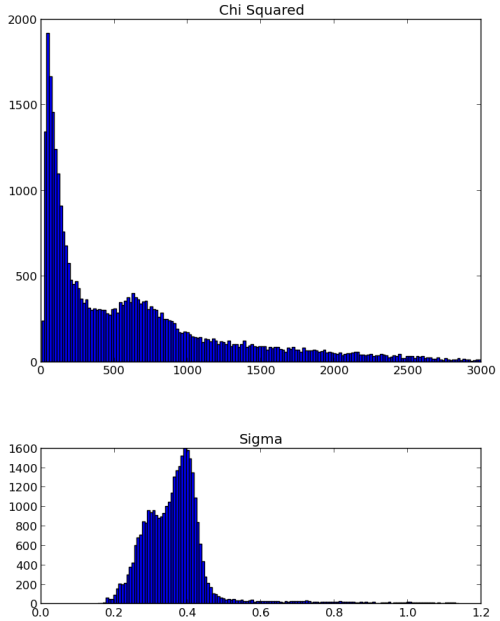
Undersampling - The Problem

- Cause - Fe^{55} hits are narrow and focused and therefore cover very few pixels (in some cases as few as one)

- Effect - The DMStack fitting algorithm cannot accurately represent the true shape of the hit

- Solution - Subdivide each pixel into an array of subpixels
- Thanks to Erin for developing and providing the code to subdivide each pixel

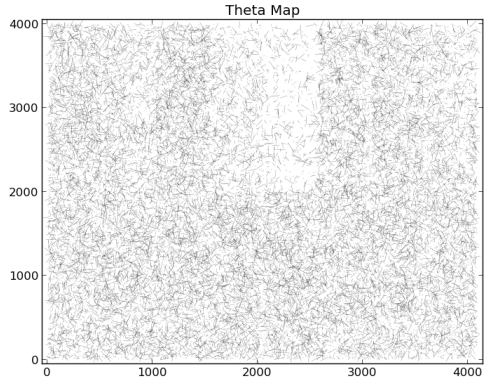
Xi^2 and Sigma Distributions

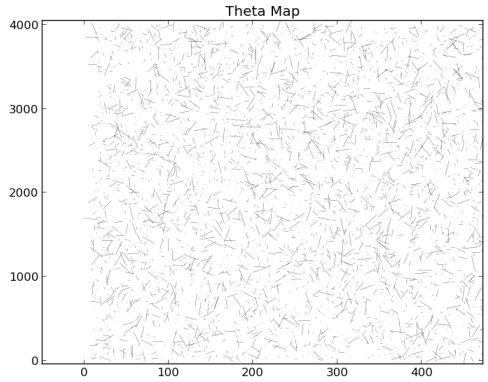


- Some unexpected behaviors observed in these data sets
- Xi^2 and Sigma distributions have unexpected humps - potentially a result of CCD
- Distributions otherwise pretty good
- Limiting Xi^2 to < 400 improves quality of some plots, for example theta distribution

First Look at Edge Effects

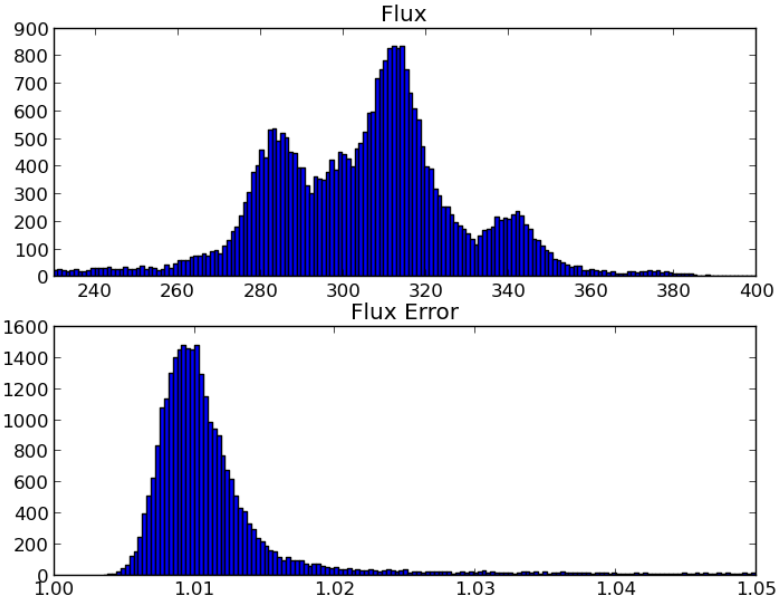
- Theta map of ellipse orientation
- Near edge of CCD more ellipses should be oriented toward edge (i.e. standard error should be smaller)
- Initial graphs look promising
- Still work to be done
- Will analyze much more data in the next few days





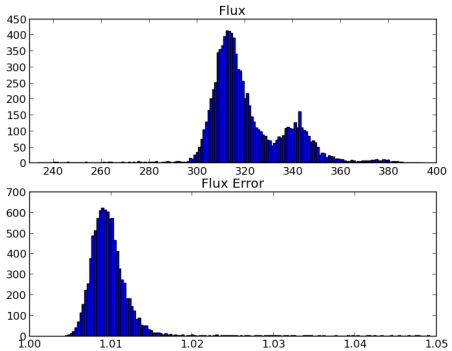
Entire CCD - Flux

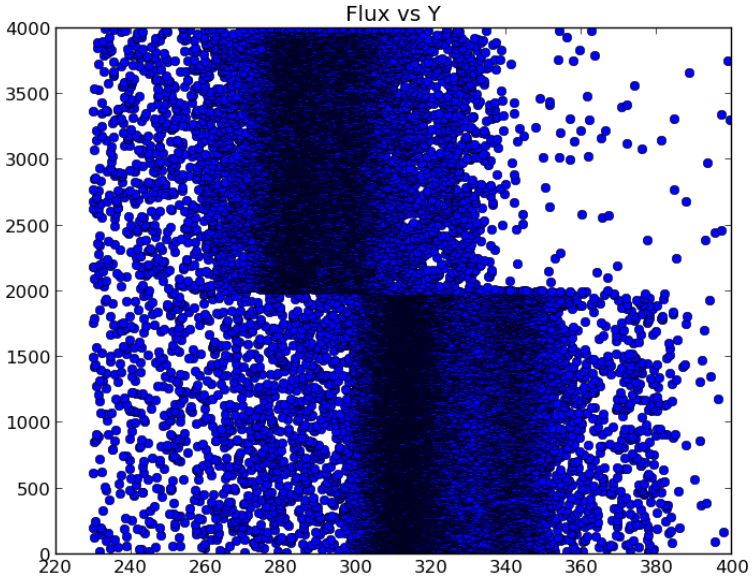
- Early flux results only looked at 1/16 of CCD
- Flux over whole CCD should match same pattern
- It doesn't - what is happening?

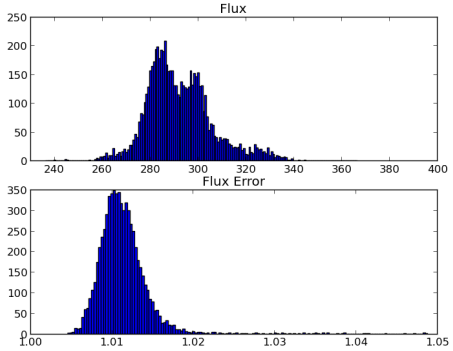


Problem with CCD?

Unfortunately, it looks like it. There is a clear and obvious discrepancy between the bottom and top halves of the CCD.







Remaining Objectives

- Analyze more data to increase statistics
- Continue looking for edge effects
- Sort out issues with sigma, flux, and error distributions (Xi^2 might help)
- Further alleviate undersampling so theta distribution is uniform
- Search for tree ring patterns in the data